Device Error Handling in ChimeraTK.

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HELMHOLTZ
RESEARCH FOR GRAND CHALLENGES

Device errors in control applications

Start a server without the hardware

- No error handling (bad)
  - just crashes, don't know why
- Typical error handling (OK)
  - Tells user it can't reach hardware
  - Quits
- Ideal error handling (Good)
  - Server starts
  - Reports device error to the control system
  - Normal operation once device is available

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Device error while server is running

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- Typical error handling (tedious)
  - Catch errors wherever you access the hardware
  - Take appropriate action
- Ideal error handling
  - ???

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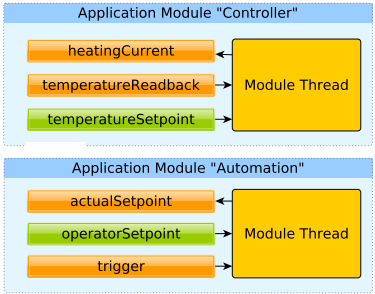
We have noticed that...

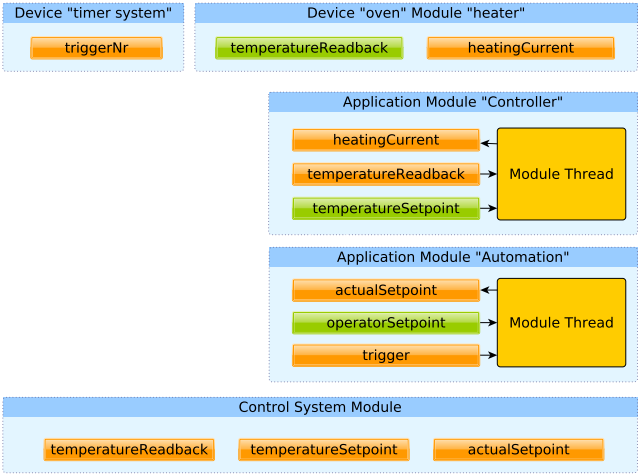
- a large fraction of code in control applications is error handling
- error handling strategy is usually the same
  - Report error to control system
  - Wait until error has gone
  - Resume operation

⇒ Lots of concepts and code copied (even inside one application)!



Modules

- Input/output variables
- Application Modules
  - One thread per module



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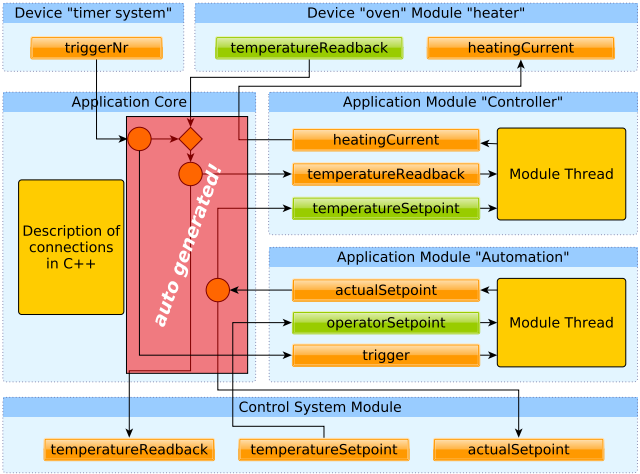
  - One thread per module
- Special modules
  - Device module
  - Control system module



Modules

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- Application Modules
  - One thread per module
- Special modules
  - Device module
  - Control system module

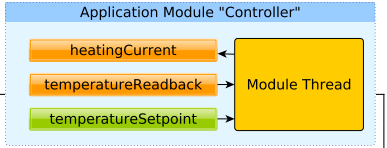
Connections

- Mostly auto-generated

High locality

- Algorithms don't need to know how variables are connected
- Perfect modularity, as modules are self-contained

Code of a module




```
void Controller::mainLoop() {

  while(true) {
      temperatureReadback.read(); // waits until temperatureReadback has been updated
      temperatureSetpoint.read(); // update the temperature setpoint

      heatingCurrent = gain * (temperatureSetpoint - temparatureReadback);

      heatingCurrent.write();
    }
  }
};
```

real code from a live demo

- Process variables are represented by inputs and outputs
- They behave like normal numbers with additional `read()` and `write()`

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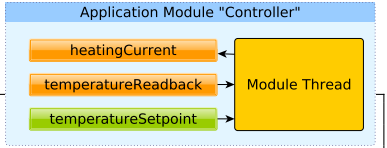


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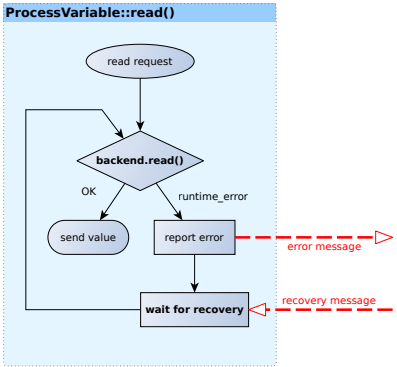
How does this help with device error handling?

ProcessVariable::read()

```
temperatureReadback.read(); // waits until temperatureReadback has been updated
temperatureSetpoint.read(); // update the temperature setpoint
```

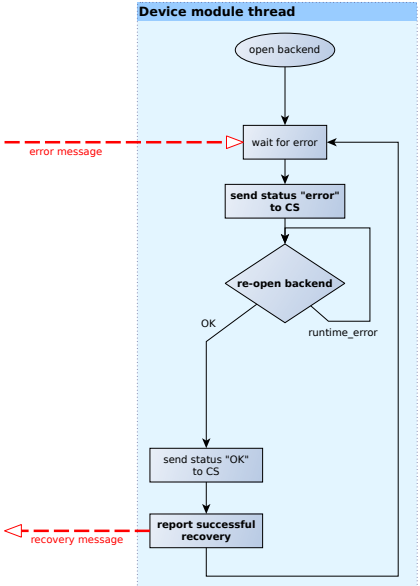
Each process variable has an error handling loop

- Reading from the device backend can cause a runtime error
- An error message is send
- Process variable waits for recovery message



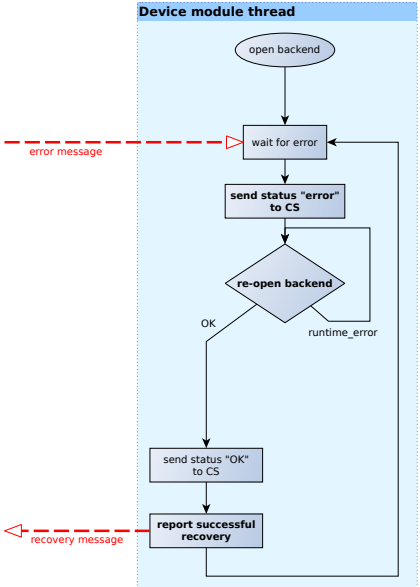
Device module thread

- Open the device backend at application start
- Wait for error messages



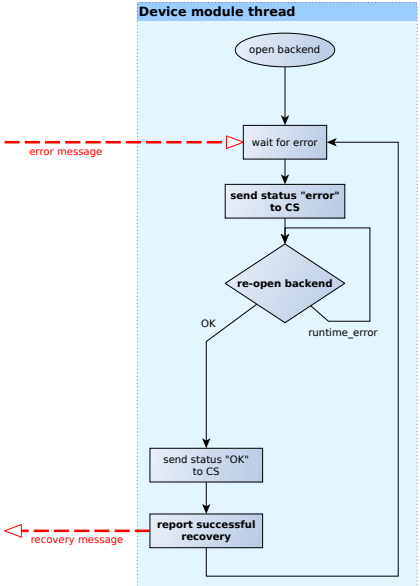
Device module thread

- Open the device backend at application start
- Wait for error messages
- Send error message to control system
- Try to re-open the device backend (inner loop)



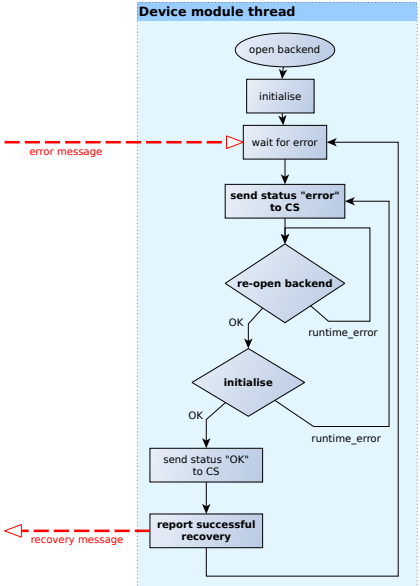
Device module thread

- Open the device backend at application start
- Wait for error messages
- Send error message to control system
- Try to re-open the device backend (inner loop)
- Send OK to control system when successful
- Send recovery message to all process variables

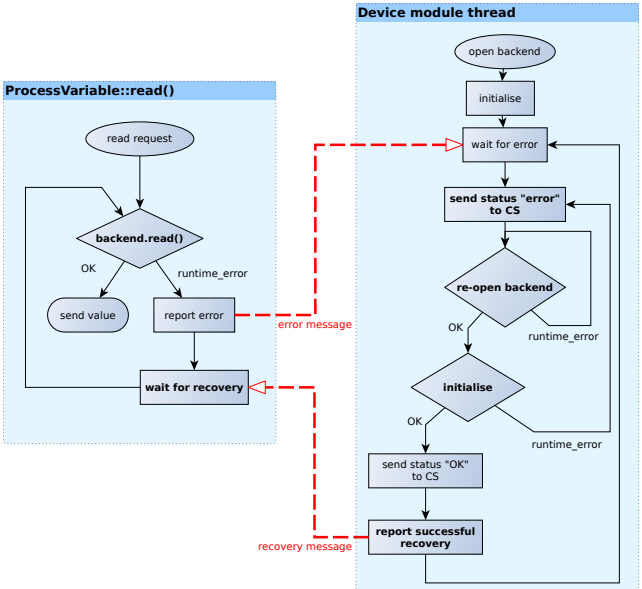


Device module thread

- Open the device backend at application start
- Run initialisation sequence
- Wait for error messages
- Send error message to control system
- Try to re-open the device backend (inner loop)
- Try to re-initialise the device
- Send OK to control system when successful
- Send recovery message to all process variables



The whole picture



Summary

ChimeraTK

- design modular, multi-threaded applications
- talk to hardware
- interface with the control system infrastructure

Device error handling in ApplicationCore

- build into the framework
- available out of the box (no extra code required)
- option to initialise device after (re-)connection

Software Repositories

All software is published under the GNU GPL or the GNU LGPL.

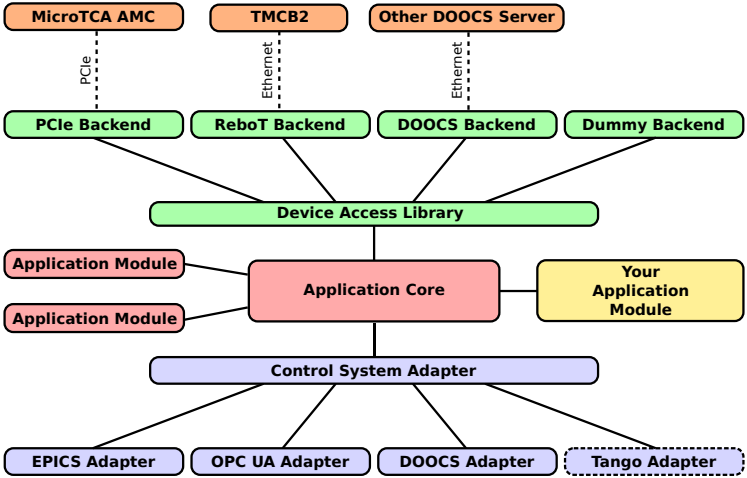
- ChimeraTK source code: https://github.com/ChimeraTK
- Ubuntu 16.04 packages are available in the DESY DOOCS repository.

Documentation and Tutorials

- API documentation https://chimeratk.github.io/
- Tuesday's tutorials on the MicroTCA Workshop Indico page
- e-mail support: chimeratk-support@desy.de

Backup.

ChimeraTK overview



What else is new in ApplicationCore?

Status monitor

- Check value for upper threshold, lower threshold or window
- Threshold for error and warning
- Pre-defined status results
  - OK
  - Error
  - Warning
  - Intentionally off
- Work in progress: **Automatic status aggregator**

Hierarchy modifier

- Model your variable content to fit the process view (not how you have to implement it in C++)
- Enables automatic connection of variables

$\Rightarrow$ Even easier connection code